Supplement to MACHINE[RY]

Formulas for the Article in this number entitled "Form[ulas ...]"

I.—FORMULAS FOR STRENGTH OF FLAT PLATES

Square Flat Plates, Supported at all Four Edges. Load Uniformly Distributed Over Unsupported Surface of Plate.

Author and Reference	Formulas as given by Author	Total Load $W = PL^2$	Unit Fiber Stress in Pounds per Square Inch $f =$	$t^2 =$	Thickness Plate in Inches $t =$	$L^2 =$	Clear Span Between Supported Edges $L =$	Uniform Load per Unit of Surface $P =$
Grashof, Trautwines C.E. Pocket Book 1906, Page 493–494	$f = \frac{CL^2P}{4t^2}$ $P = \frac{4ft^2}{CL^2}$ $C = 1.125$	$3.56\,ft^2$	$0.28\frac{W}{t^2}$	$0.28\frac{W}{f}$	$0.53\sqrt{\frac{W}{f}}$			
			$0.28\frac{PL^2}{t^2}$	$0.28\frac{PL^2}{f}$	$0.53L\sqrt{\frac{P}{f}}$	$3.56\frac{ft^2}{P}$	$1.89t\sqrt{\frac{f}{P}}$	$3.56\frac{ft^2}{L^2}$
J. B. Johnson, The Materials of Construction 1897, Page 93	$t = 0.61L\sqrt{\frac{P}{f}}$	$2.67\,ft^2$	$0.375\frac{W}{t^2}$	$0.375\frac{W}{f}$	$0.61\sqrt{\frac{W}{f}}$			
			$0.375\frac{PL^2}{t^2}$	$0.375\frac{PL^2}{f}$	$0.61L\sqrt{\frac{P}{f}}$	$2.67\frac{ft^2}{P}$	$1.634t\sqrt{\frac{f}{P}}$	$2.67\frac{ft^2}{L^2}$
Rankine, Civil Engineering, Page 543	Bending Moment $M = \frac{WL}{16}$	$2.67\,ft^2$	$0.375\frac{W}{t^2}$	$0.375\frac{W}{f}$	$0.61\sqrt{\frac{W}{f}}$			
			$0.375\frac{PL^2}{t^2}$	$0.375\frac{PL^2}{f}$	$0.61L\sqrt{\frac{P}{f}}$	$2.67\frac{ft^2}{P}$	$1.634t\sqrt{\frac{f}{P}}$	$2.67\frac{ft^2}{L^2}$
Wm. F. Fischer	$\frac{WL}{24} = \frac{fLt^2}{6}$ or $M = M_r$	$4\,ft^2$	$0.25\frac{W}{t^2}$	$0.25\frac{W}{f}$	$0.5\sqrt{\frac{W}{f}}$			
			$0.25\frac{PL^2}{t^2}$	$0.25\frac{PL^2}{f}$	$0.5L\sqrt{\frac{P}{f}}$	$4\frac{ft^2}{P}$	$2t\sqrt{\frac{f}{P}}$	$4\frac{ft^2}{L^2}$

Compiled by William F. Fischer

II.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Square Flat Plates Firmly Secured Along All Four Edges, Load Uniformly Distributed Over Unsupported Surface of Plate.

Author and Reference	Formulas as Given by Author	Total Load $PL^2 = W =$	Unit Fiber Stress Pounds per sq. in. $f =$	$t^2 =$	Thickness of Plate Inches $t =$	$L^2 =$	Clear Span Between Supported Edges $L =$	Uniform Load per Unit of Surface $P =$
Grashof, Trautwines C.E. Pocket Book 1906, Page 494	$f = \frac{CL^2P}{4t^2}$ $P = \frac{4ft^2}{CL^2}$ $C = 0.75$	$5.33\,ft^2$	$0.1875\frac{W}{t^2}$	$0.1875\frac{W}{f}$	$0.433\sqrt{\frac{W}{f}}$			
			$0.1875\frac{PL^2}{t^2}$	$0.1875\frac{PL^2}{f}$	$0.433L\sqrt{\frac{P}{f}}$	$5.33\frac{ft^2}{P}$	$2.31t\sqrt{\frac{f}{P}}$	$5.33\frac{ft^2}{L^2}$
J. B. Johnson, The Materials of Construction 1897 Page 73	$f = \frac{9PL^2}{32t^2}$ $t = 0.53l\sqrt{\frac{P}{f}}$	$3.6\,ft^2$	$0.28\frac{W}{t^2}$	$0.28\frac{W}{f}$	$0.53\sqrt{\frac{W}{f}}$			
			$0.28\frac{PL^2}{t^2}$	$0.28\frac{PL^2}{f}$	$0.53L\sqrt{\frac{P}{f}}$	$3.6\frac{ft^2}{P}$	$1.89t\sqrt{\frac{f}{P}}$	$3.6\frac{ft^2}{L^2}$
Unwin, Elements of Machine Design Page 73	$f = \frac{L^2P}{4t^2}$	$4\,ft^2$	$0.25\frac{W}{t^2}$	$0.25\frac{W}{f}$	$0.5\sqrt{\frac{W}{f}}$			
			$0.25\frac{PL^2}{t^2}$	$0.25\frac{PL^2}{f}$	$0.5L\sqrt{\frac{P}{f}}$	$4\frac{ft^2}{P}$	$2t\sqrt{\frac{f}{P}}$	$4\frac{ft^2}{L^2}$

Square Flat Plate, Supported At All Four Edges, Loaded at Center With a Concentrated Load W.

Author and Reference	Formulas as Given by Author	Central Load $W =$	Unit Stress in Extreme Fiber. Pounds per sq. inch $f =$	$t^2 =$	Thickness Plate in Inches $t =$
Rankine, Civil Engineering, Page 543	Bending Moment $M = \frac{3WL}{16}$	$0.9\,ft^2$	$1.125\frac{W}{t^2}$	$1.125\frac{W}{f}$	$1.06\sqrt{\frac{W}{f}}$
Grashof, Trautwines C.E. Pocket Book, Page 493	$f = \frac{3CW}{4t^2}$ $W = \frac{4ft^2}{3C}$ $C = 2$	$0.667\,ft^2$	$1.5\frac{W}{t^2}$	$1.5\frac{W}{f}$	$1.23\sqrt{\frac{W}{f}}$

Square Flat Plate, Firmly Secured at all Four Edges, Loaded at Center with a Concentrated Load W.

Author and Reference	Formulas as Given by Author	Central Load $W =$	Unit Stress in Extreme Fiber. Pounds per sq. inch $f =$	$t^2 =$	Thickness Plate in Inches $t =$
Grashof, Trautwines C.E. Pocket Book, Page 493	$f = \frac{3CW}{4t^2}$ $W = \frac{4ft^2}{3C}$ $C = 1.75$	$0.762\,ft^2$	$1.31\frac{W}{t^2}$	$1.31\frac{W}{f}$	$1.144\sqrt{\frac{W}{f}}$

Compiled by William F. Fischer

III.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Flat Rectangular Plates, Supported at all Four Edges and Loaded with a Uniformly Distributed Load $W = PLl$.

Author and Reference	Formulas as Given by Author	Total Load W on Plate =	Pressure on Plate per Unit of Area P =	Unit Stress in Extreme Fiber of Material f =	Thickness of Plate, Inches t =
Johnson, Materials of Construction, L = 2l or greater	$f = \frac{3Pl^2}{4t^2}$	$1.34\frac{fLt^2}{l}$		$0.75\frac{Wl}{Lt^2}$	$0.866\sqrt{\frac{Wl}{fL}}$
	$t = \frac{l}{2}\sqrt{\frac{3P}{f}}$		$1.34\frac{ft^2}{l^2}$	$0.75\frac{Pl^2}{t^2}$	$0.866l\sqrt{\frac{P}{f}}$
Johnson, Where $L = 1\frac{1}{2}l$ about	$f = \frac{3}{4}\cdot\frac{3Pl^2}{4t^2}$	$1.8\frac{fLt^2}{l}$		$0.56\frac{Wl}{Lt^2}$	$0.75\sqrt{\frac{Wl}{fL}}$
	$t = \frac{3}{4}l\sqrt{\frac{P}{f}}$		$1.78\frac{ft^2}{l^2}$	$0.56\frac{Pl^2}{t^2}$	$0.75l\sqrt{\frac{P}{f}}$
Rankine, Civil Engineering Page 543	$M = \frac{WL^4l}{8(L^4+l^4)}$	$1.34\frac{ft^2(L^4+l^4)}{L^3l}$		$0.75\frac{WL^3l}{t^2(L^4+l^4)}$	$0.866\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
			$1.34\frac{ft^2(L^4+l^4)}{L^4l^2}$	$0.75\frac{Rl^2L^4}{t^2(L^4+l^4)}$	$0.866L^2l\sqrt{\frac{P}{f(L^4+l^4)}}$
Grashof, Trautwines Pocket Book Page 493	$f = \frac{CPL^2l^2}{2t^2(L^2+l^2)}$	$1.77\frac{ft^2(L^2+l^2)}{Ll}$		$0.56\frac{WLl}{t^2(L^2+l^2)}$	$0.75\sqrt{\frac{WLl}{f(L^2+l^2)}}$
	$C = 1.125$		$1.77\frac{ft^2(L^2+l^2)}{L^2l^2}$	$0.56\frac{PL^2l^2}{t^2(L^2+l^2)}$	$0.75Ll\sqrt{\frac{P}{f(L^2+l^2)}}$
Fischer	$\frac{Pl^2(2N+L)}{24} = \frac{fLt^2}{6}$				
			$\frac{4fLt^2}{l^2(2N+L)}$	$\frac{Pl^2(2N+L)}{4Lt^2}$	$0.5l\sqrt{\frac{P(2N+L)}{fL}}$

M = Maximum Bending Moment, Inch Pounds
L = Longest Span, and l = Shortest Span Between Edge of Supports
N = L − l W, P, f, and t as given above.

Note:- If L and l are given in feet P = Pounds per sq. foot. If L and l are in inches, P = Pounds per sq. inch. W = PlL.

Compiled by William F. Fischer

IV.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Flat Rectangular Plates, Firmly Secured at all Four Edges Loaded with a Uniformly Distributed Load $W = PLl$.

Author and Reference	Formulas as Given by Author	Total Load W on Plate =	Pressure on Plate per Unit of Area P =	Unit Stress in Extreme Fiber of Material f =	Thickness of Plate in Inches t =
Grashof, Trautwines C.E. Pocket Book, Page 493	$f = \frac{CPL^2l^2}{2t^2(L^2+l^2)}$	$2.67\frac{ft^2(L^2+l^2)}{Ll}$		$0.375\frac{WLl}{t^2(L^2+l^2)}$	$0.62\sqrt{\frac{WLl}{f(L^2+l^2)}}$
	$C = 0.75$		$2.67\frac{ft^2(L^2+l^2)}{L^2l^2}$	$0.375\frac{PL^2l^2}{t^2(L^2+l^2)}$	$0.62Ll\sqrt{\frac{P}{f(L^2+l^2)}}$
Unwin, Elements of Machine Design, Page 93	$f = \frac{PL^4l^2}{2t^2(L^4+l^4)}$	$2.\frac{ft^2(L^4+l^4)}{L^3l}$		$0.5\frac{WL^3l}{t^2(L^4+l^4)}$	$0.7\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
			$2.\frac{ft^2(L^4+l^4)}{L^4l^2}$	$0.5\frac{PL^4l^2}{t^2(L^4+l^4)}$	$0.7L^2l\sqrt{\frac{P}{f(L^4+l^4)}}$
Neglecting End Bearings Entirely Where L = 2l or Greater, and Treating as a Simple Beam, Uniformly Loaded — See Below.					
Bending Moment $M = \frac{Wl}{12}$	Resisting Moment $M_1 = \frac{fLt^2}{6}$	$2.\frac{fLt^2}{l}$		$0.5\frac{Wl}{Lt^2}$	$0.7\sqrt{\frac{Wl}{fl}}$
or $M = \frac{PLl^2}{12}$	$\frac{Wl}{12} = \frac{fLt^2}{6}$		$2.\frac{ft^2}{l^2}$	$0.5\frac{Pl^2}{t^2}$	$0.7l\sqrt{\frac{P}{f}}$
Assuming ¾ of Load to be Carried at the Sides and ¼ Carried at the Ends, Where $L = 1\frac{1}{2}l$ about, (Treated as a Simple Beam) — See Below.					
$M = \frac{3}{4}\cdot\frac{Wl}{12}$	$M_1 = \frac{fLt^2}{6}$	$2.67\frac{fLt^2}{l}$		$0.375\frac{Wl}{Lt^2}$	$0.62\sqrt{\frac{Wl}{fL}}$
or $M = \frac{3}{4}\cdot\frac{PLl^2}{12}$	$\frac{3Wl}{48} = \frac{fLt^2}{6}$		$2.67\frac{ft^2}{l^2}$	$0.375\frac{Pl^2}{t^2}$	$0.62l\sqrt{\frac{P}{f}}$

M = Maximum Bending Moment, Inch Pounds
L = Longest Span, Between Supports
l = Shortest Span, Between Supports

W, P, f, and t as given above
Note:- If L and l are given in inches, P = pounds per sq. inch. If L and l are given in feet, P = pounds per sq. foot.

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vL^3l
(L^4+l^4)
P
(L^4+l^4)
Ll
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P
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$V+L)$

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